U.S. FISH AND WILDLIFE SERVICE
MAINE FIELD OFFICE
SPECIAL PROJECT REPORT: FY05-MEFO-1-EC

MERCURY IN BIRD EGGS

FROM COASTAL MAINE

February 2005

Mission Statement
U.S. Fish and Wildlife Service

"Our mission is working with others to conserve, protect, and enhance the nation's fish and wildlife and their habitats for the continuing benefit of the American people."

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MERCURY IN BIRD EGGS FROM COASTAL MAINE

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February 2005

EXECUTIVE SUMMARY

Maine's coastal islands and beaches provide important nesting habitat for piping plover (*Charadrius melodus*), least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), Arctic tern (*Sterna paradisaea*), Atlantic puffin (*Fratercula arctica*), black guillemot (*Cepphus grylle*), and common eider (*Somateria mollissima*). These species are managed and regularly monitored by the U.S. Fish and Wildlife Service (USFWS), National Audubon Society (NAS), Maine Department of Inland Fisheries and Wildlife (MDIFW), BioDiversity Research Institute (BRI), Maine Audubon Society (MAS) and other partners in the Gulf of Maine Seabird Working Group. Each nesting season, these organizations collect nonviable and abandoned eggs when available.

Relatively few contaminant investigations have been performed with birds at coastal sites in Maine. In particular, little is known about mercury exposure in bird species using coastal beaches and islands. To address this data gap, we summarize mercury exposure in nonviable and abandoned bird eggs collected between 1993 and 2004 from ten locations along the Maine coast. Eighty-two eggs from seven species were collected. Fifty eggs were analyzed individually for mercury and 32 eggs were formed into six species-specific composites prior to analysis.

Mercury concentrations in egg samples ranged from 0.06 ppm to 0.33 ppm, fresh wet weight. Individual or mean concentrations among species were

Black Guillemot	0.31 ppm
Atlantic Puffin	0.17 ppm
Piping Plover	0.17 ppm
Common Eider	0.12 ppm
Least Tern	0.11 ppm
Common Tern	0.11 ppm
Arctic Tern	0.10 ppm

In general, mercury concentrations in bird eggs from the Maine coast are not elevated compared to suggested embryotoxic thresholds (0.80 ppm) or ecological effect screening benchmarks (0.50 ppm). Although elevated mercury levels were not detected in egg samples, additional monitoring is recommended to profile temporal and spatial mercury exposure patterns in birds nesting along the Maine coast.

PREFACE

This report summarizes screening-level surveys of mercury in bird eggs collected between 1993 and 2004 along the Maine coast. Analytical work for this report was completed under USFWS Analytical Control Facility Catalog Numbers 5030029, 5100005, 5100008, and 5100011.

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY05-MEFO-1-EC and be directed to:

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 Copies of this report may be downloaded from the Maine Field Office Environmental Contaminants web site http://mainecontaminants.fws.gov .

This report complies with the peer-review and certification provisions of the Information Quality Act (Public Law 106-554, Section 515).

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1. Introduction

Maine's coastal islands and beaches provide important nesting habitat for piping plover (species alpha code PIPL, *Charadrius melodus*), least tern (LETE, *Sterna antillarum*), common tern (COTE, *Sterna hirundo*), Arctic tern (ARTE, *Sterna paradisaea*), Atlantic puffin (ATPU, *Fratercula arctica*), black guillemot (BLGU, *Cepphus grylle*), and common eider (COEI, *Somateria mollissima*). These species are managed and regularly monitored by the U.S. Fish and Wildlife Service (USFWS), National Audubon Society (NAS), Maine Department of Inland Fisheries and Wildlife (MDIFW), BioDiversity Research Institute (BRI), Maine Audubon Society (MAS), and other partners in the Gulf of Maine Seabird Working Group. Each nesting season, these organizations collect nonviable and abandoned eggs when available.

Relatively few contaminant investigations have been performed with birds at coastal sites in Maine. In particular, little is known about mercury exposure in bird species using coastal beaches and islands. To address this data gap, we summarize mercury data in nonviable and abandoned bird eggs collected between 1993 and 2004 from ten locations along the Maine coast. Some of these data have been reported previously (Mierzykowski *et al*. 2001, Mierzykowski and Carr 2004). This summary report focuses on mercury results in those previous surveys and includes new exposure data from the 2004 nesting season.

Mercury is a global contaminant that bioaccumulates in fish and wildlife species and biomagnifys through food chains. Birds and their eggs have been valuable bioindicators to assess mercury contamination in a variety of habitats (Ohlendorf and Harrison 1986, Welch 1994, Koster *et al*. 1996, Evers *et al*. 1998, Braune *et al*. 2001, Burgess and Braune 2002, Evers *et al*. 2003). Periodic monitoring of mercury levels in bird eggs and other tissues will provide important information on the distribution of this contaminant in the Gulf of Maine.

2. Purpose

The purpose of this project was to determine mercury exposure in bird eggs collected from coastal Maine between 1993 and 2004.

3. Study Area

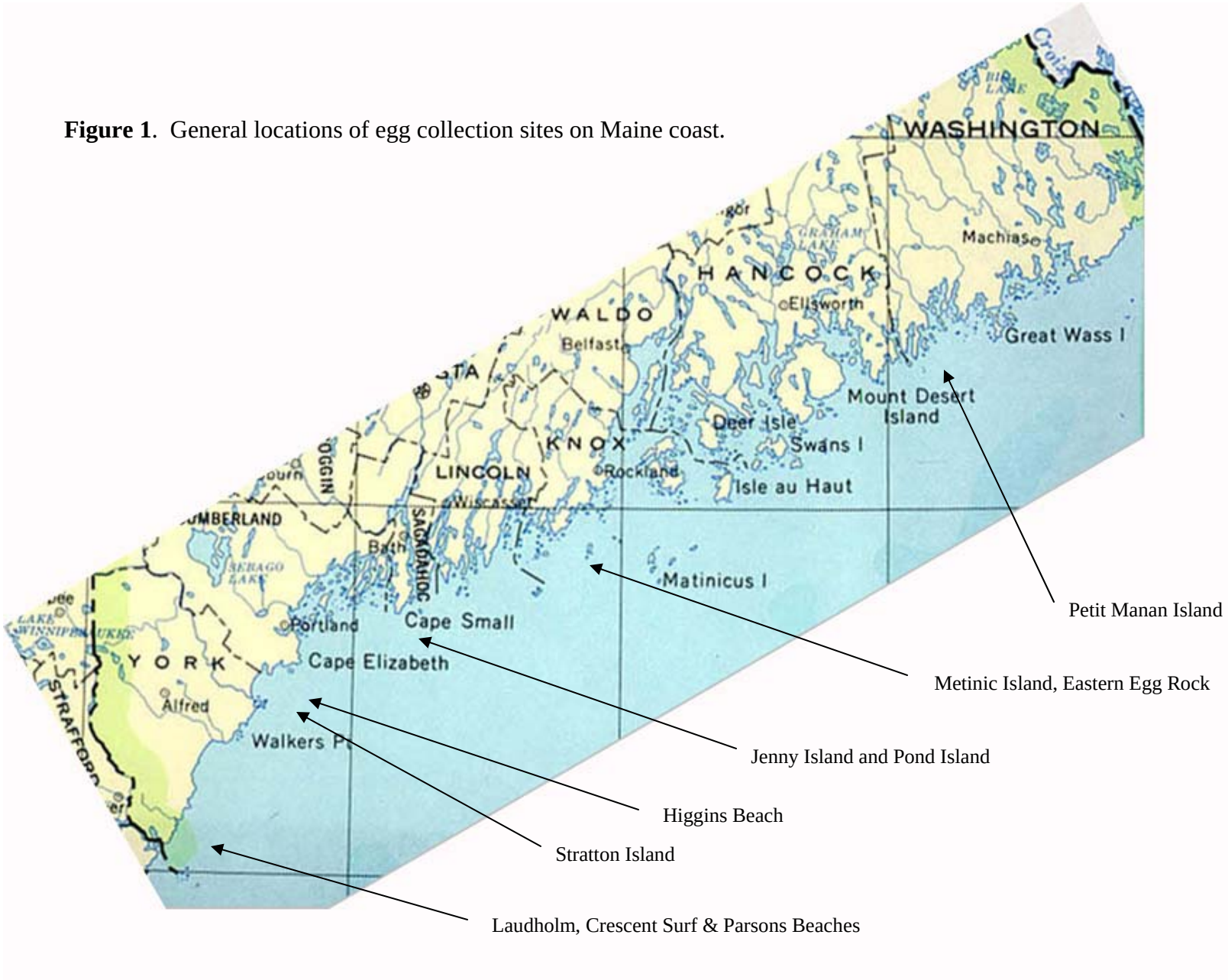
Nonviable and abandoned eggs of seven bird species were collected from ten areas along the Maine coast (Figure 1). South to northeast, the areas were Laudholm Beach, Crescent Surf Beach, Parsons Beach, Higgins Beach, Stratton Island, Jenny Island, Pond Island, Eastern Egg Rock, Metinic Island, and Petit Manan Island. The approximate latitude and longitude of each collection location are listed in Table 1. Each of the collection locations represents critically important nesting habitat in the state.

Table 1. Coordinates of collection locations (south to northeast) and species collected.

Location	Species	Latitude	Longitude
Laudholm Beach	PIPL	43° 20' 00"	070° 32' 29"
Crescent Surf Beach	LETE	43° 20' 11"	070° 32' 17"
Parson Beach	PIPL	43° 20' 42"	070° 31' 00"
Stratton Island	COTE	43° 30' 20"	070° 18' 43"
Higgins Beach	LETE	43° 33' 46"	070° 16' 22"
Jenny Island	COTE	43° 45' 52"	069° 54' 30"
Pond Island	COTE	43° 44' 19"	069° 46' 14"
Eastern Egg Rock	COTE	43° 51' 35"	069° 22' 56"
Metinic Island	COTE	43° 53' 29"	069° 07' 26"
	COEI		
Petit Manan Island	COTE	44° 23' 02"	067° 49' 58"
	ARTE		
	ATPU		
	COEI		

Note: Piping plover eggs from Laudholm Beach and Parson Beach were combined into one composite sample. Coordinates were derived from a computer mapping program and should be considered approximate.

Figure 1. General locations of egg collection sites on Maine coast.



4. Methods

Nonviable and abandoned eggs from seven bird species were collected from nests at ten locations along the Maine coast. Unbroken eggs were immediately processed or stored in freezers in chemically-clean jars or plastic bags until processed. At processing, each egg was weighed (0.1 grams), and the length and breadth were measured with dial calipers to the nearest 0.1 millimeter. Eggs were scored with dedicated scalpels, opened at the equator; and, by species and location, the contents placed in labeled, chemically-clean jars. Sample jars were immediately frozen for storage. Upon catalog approval, samples were shipped frozen via overnight priority mail to analytical laboratories.

Eighty-two eggs from seven species were collected. Fifty eggs were analyzed individually for mercury and 32 eggs were formed into six species-specific composites prior to analysis. Samples were submitted to three contract laboratories of the USFWS Analytical Control Facility for cold vapor atomic absorption mercury analysis. Catalog 5030029 was analyzed by Hazelton Environmental Service, Inc., of Madison, Wisconsin. Catalogs 5100005 and 5100008 were analyzed by Laboratory and Environmental Testing, Inc., of Columbia, Missouri. Analyses for Catalog 5100011 were performed by the Trace Element Research Laboratory of College Station, Texas.

Quality assurance and quality control (QA/QC) procedures included procedural blanks, duplicates, certified reference materials, and spike recoveries. The USFWS Analytical Control Facility reviewed QA/QC results and accepted all data packages.

5. Analytical Results

Analytical results are summarized in Table 2. Laboratory results were reported in micrograms per gram (µg/g = parts-per-million) dry weight and wet weight. The results in the text and table of this report are presented in µg/g (ppm) on a fresh wet weight basis. Fresh wet weight concentrations in egg composites were calculated by adjusting laboratory-reported wet weights to account for moisture loss after egg laying (Stickel *et al.* 1973, Hoyt 1979). Since several eggs were formed into species-specific composites, the mean sample weight and mean calculated egg volume were used to develop the fresh wet weight adjustment factor for each composite.

Mercury concentrations in egg samples ranged from 0.06 µg/g to 0.33 µg/g, fresh wet weight. Individual or mean concentrations among species were black guillemot 0.31 µg/g, Atlantic puffin 0.17 µg/g, piping plover 0.17 µg/g, common eider 0.12 µg/g, least tern 0.11 µg/g, common tern 0.11 µg/g, and Arctic tern 0.10 µg/g.

Table 2. Mercury in bird eggs from coastal Maine, ug/g fresh wet weight.

Species	Collection Year	Location	Type of Sample	Sample or Mean Conc.	Std Dev	Range
Atlantic Puffin	2004	Petit Manan Island	1 egg	0.17		
Black Guillemot	2004	Petit Manan Island	4 individual eggs	0.31	0.024	0.29 - 0.33
Piping Plover	2003	Laudholm & Parsons Beach	1 four egg composite	0.17		
Arctic Tern	1993	Petit Manan Island	5 individual eggs	0.10	0.022	0.08 - 0.14
Common Tern	2004	Stratton Island	5 individual eggs	0.12	0.020	0.09 - 0.14
Common Tern	2003	Stratton Island	1 five egg composite	0.12		
Common Tern	2004	Jenny Island	5 individual eggs	0.10	0.032	0.07 - 0.15
Common Tern	2004	Pond Island	5 individual eggs	0.15	0.039	0.13 - 0.20
Common Tern	2003	Pond Island	1 two egg composite	0.08		
Common Tern	2004	Metinic Island	5 individual eggs	0.10	0.048	0.07 - 0.18
Common Tern	2004	Eastern Egg Rock	5 individual eggs	0.12	0.021	0.10 - 0.15
Common Tern	2004	Petit Manan Island	5 individual eggs	0.10	0.021	0.07 - 0.12
Common Tern	2003	Petit Manan Island	1 five egg composite	0.08		
Least Tern	2003	Crescent Surf Beach	1 eight egg composite	0.12		
Least Tern	2003	Higgins Beach	1 eight egg composite	0.11		
Common Eider	2004	Metinic Island	4 individual eggs	0.10	0.033	0.06 - 0.13
Common Eider	2004	Petit Manan Island	6 individual eggs	0.14	0.044	0.06 - 0.18

6. Discussion

Piping plover, least tern, Arctic tern, common tern, Atlantic puffin, black guillemot, and common eider eggs were examined to determine mercury content. Concentrations in eggs typically represent contaminants sequestered in the egg by females at the time of egg formation (Burger and Gochfeld 1996). These egg contaminants can be derived from recent exposure or from mobilization from other tissues in the female (Burger *et al.* 1999). Hence, the contaminant levels in eggs may reflect local contaminant conditions or reflect a contaminant burden accumulated by females during migration.

In this survey of mercury in available eggs, no pre-conceived study design was developed to rigorously differentiate among species or locations. Basically, any nonviable or abandoned eggs that were available were analyzed. It has been reported that in certain species contaminant concentrations may vary within an egg clutch (Nisbet 1982, Becker 1992). Since eggs were opportunistically collected in this study, it is not known if the egg collected was the first laid (i.e., the egg with the higher mercury content) or the second or third egg laid in the clutch. In some instances, to maximize the use of analytical funds, we analyzed multi-egg composites from several nests at certain locations. Overall, decisions in the egg survey were based on practicality, technical utility, and the availability of samples and funding. Readers should take into account these limitations when making data interpretations.

Mercury is a mutagen, teratogen, and carcinogen which bioconcentrates in organisms and biomagnifies through food chains (Eisler 1987). Mercury concentrations of 0.5 µg/g to 2.0 µg/g in eggs are sufficient to reduce egg viability, hatchability, embryo survival and chick survival in nonmarine birds (Thompson 1996). Embryo deformities may occur in bird eggs containing about 1 µg Hg/g, with sensitive embryos experiencing mortality with mercury levels as low as 0.74 µg/g (Heinz and Hoffman 2003). Mercury sensitivity varies among bird species (Fimreite 1971, Barr 1986) and within clutches (Heinz and Hoffman 2003). An often used reproductive effect endpoint for mercury in bird eggs is 0.80 µg/g (Heinz 1979, Henny *et al*. 2002), while other investigators and ecological risk assessors may use 0.50 µg Hg/g as an ecological effect screening benchmark value of (RAIS 2004).

None of the eggs examined in this survey exceeded suggested reproductive effect endpoints or screening benchmark values for mercury.

7. Summary

Mercury concentrations were determined in nonviable and abandoned bird eggs collected between 1993 and 2004 from ten locations along the Maine coast. Eighty-two eggs from seven species were collected. Fifty eggs were analyzed individually for mercury and 32 eggs were formed into six species-specific composites prior to analysis.

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